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 17/Eng02/069
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using Leibnitz method

$$x(x-1)y'' + (3x-1)y' + y = 0$$

$$(x^2-x)y'' + (3x-1)y' - y = 0$$

$$(x^2-x)y^{n+2} + n(3x-1)y^{n+1} - y^n = 0$$

$$+ n(3)y^n + y^n = 0$$

$$(x^2-x)y^{n+2} + n(3x-1)y^{n+1} + n(n-1)y^n + (3x-1)y^{n+1} + 3yn^n + y^n = 0$$

$$+ 3yn^n + y^n = 0$$

$$(x^2-x)y^{n+2} + (2nx-n)y^{n+1} + (n^2-n)y^n + (3x-1)y^{n+1} + 3yn^n + y^n = 0$$

$$(x^2-x)y^{n+2} + (2nx-n+3x-1)y^{n+1} + (n^2-n+3n+1)y^n = 0$$

$$(x^2-x)y^{n+2} + (2nx-n+3n-1)y^{n+1} + (n^2+2n+1)y^n = 0$$

$$y^n = 0$$

when $x=0$

$$(2n(0)-n+3(0)-1)y^{n+1} + (n^2+2n+1)y^n = 0$$

$$(-n-1)y^{n+1} + (n^2+2n+1)y^n = 0$$

$$y^{n+1} = -1(n^2+2n+1)y^n$$

$$y^{n+1} = \frac{(n^2+2n+1)y^n}{(n+1)}$$

$$(y^{n+1})_0 = \frac{(n^2+2n+1)}{(n+1)} y_0$$

$$(y^{n+1})_0 = \frac{(n+1)}{(n+1)} (y^n)_0$$

$$(y^{n+1})_0 = (n+1)(y^n)_0$$

$$\begin{aligned}
 n=0 & \quad y_1 = 1y^0 \\
 n=1 & \quad y_2 = 2(y)_0 \\
 n=2 & \quad y_3 = 3y^2 = 3(2)y' = 6(y')_0 \\
 n=3 & \quad y_4 = 4y^3 = 4(3)(2)y' = 24(y')_0 \\
 n=4 & \quad y_5 = 5y^4 = 5(4)(3)(2)y' = 120(y')_0 \\
 n=5 & \quad y_6 = 6y^5 = 6(5)(4)(3)(2)y' = 720(y')_0 \\
 n=6 & \quad y_7 = 7y^6 = 7(6)(5)(4)(3)(2)y' = 5040(y')_0
 \end{aligned}$$

Maclaurin Series

$$\begin{aligned}
 y &= y_0 + \frac{x}{1!} (y^1)_0 + \frac{x^2}{2!} (y^2)_0 + \frac{x^3}{3!} (y^3)_0 + \frac{x^4}{4!} (y^4)_0 + \frac{x^5}{5!} (y^5)_0 + \frac{x^6}{6!} (y^6)_0 + \frac{x^7}{7!} (y^7)_0 \\
 &= y^0 + x (y^1)_0 + \frac{x^2}{2!} (2y^1)_0 + \frac{x^3}{3!} (3! y^1)_0 \\
 &+ \frac{x^4}{4!} (4! y^1)_0 + \frac{x^5}{5!} (5! y^1)_0 + \frac{x^6}{6!} (6! y^1)_0 + \frac{x^7}{7!} (7! y^1)_0 \\
 &= y^0 + x (y^1)_0 + x^2 (y^1)_0 + x^3 (y^1)_0 + x^4 (y^1)_0 + x^5 (y^1)_0 + x^6 (y^1)_0 + x^7 (y^1)_0 \\
 &= y^0 + y^1 (x + x^2 + x^3 + x^4 + x^5 + x^6 + x^7)
 \end{aligned}$$

Recall

$$y' = y'$$

$$y_0 = (1 + x + x^2 + x^3 + x^4 + x^5 + x^6 + x^7)$$

$$y' = 0.0005$$

$$y^0 = 0.0005, \text{ when } x=5$$

$$y^3 = 0.0005 (1 + 5 + 5^2 + 5^3 + 5^4 + 5^5 + 5^6 + 5^7)$$

$$= 0.0005 (97656)$$

$$= 48.828 \approx 49$$

when $x = 8$, $y_0 = 0.0005$

$$y^8 = 0.0005 (1 + 8 + 8^2 + 8^3 + 8^4 + 8^5 + 8^6 + 8^7)$$

$$= 0.0005 (2396745)$$

$$= 1198.3725$$

$$\approx 1198 //$$

$$x = 10$$

$$y_{10} = 0.0005 (1 + 10 + 10^2 + 10^3 + 10^4 + 10^5 + 10^6 + 10^7)$$

$$= 0.0005 (11111111)$$

$$= 5555.5555$$

$$\approx 5556 //$$

Command window

clc

clear all

close all

syms x y

xc = 0:0.1:10

y = (0.0005) (1 + x + x² + x³ + x⁴ + x⁵ + x⁶ + x⁷)

yn = subs(y)

yn = double(yn)

plot(xc, yn)

x label('xc')

y label('T')

grid on

grid minor

axis tight